CONSTRAINTS ON SOLAR WIND PLASMA PROPERTIES DERIVED FROM COORDINATED CORONAL OBSERVATIONS

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Annual Report

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Annual Report on the grant NAG5-9564 "Constraints on Solar Wind Plasma Properties Derived from Coordinated Coronal Observations"

1.1 Scope of the Investigation

The goal of the proposed research is to increase the understanding of coronal plasma phenomena by making use of different observational approaches and combine the observations with the necessary theoretical considerations.

1.2 Progress Made During Period 08/01/01 to 07/31/02

We continued to study the formation of spectral lines in the corona/transition region. The focus was on spectral lines commonly used as density/ temperature diagnostic, mainly the lines Mg IX λ 706 and 749, and Si VIII λ 1440 and 1445 which were observed by SUMER in polar coronal hole and other coronal regions. We investigated these spectral lines for density and temperature dependence and found that the Mg lines are indeed a good temperature diagnostic, basically independent of density.

We compared the spectral line ratios that would arise from the type of temperature profile commonly used to explain in situ ion fractions with the actual observed line ratios (see Figure 1, solid lines). Also shown in this figure are the observed values of the ratios from Wilhelm et al. (1998, dotted lines). It is quite obvious from this figure that the type of temperature profiles derived from the charge state measurements results not only in the wrong values of the line ratios, but also the gradients of these curves are completely different. This study shows, in agreement with our previous studies, that there is a significant discrepancy between in situ ion fractions and observed coronal electron temperatures.

We also carried out a theoretical study to investigate how large the electron temperatures can be in the near sun region. We find that if in situ observations of mass flux and electron temperatures are taken into account, then the high electron temperatures necessary to explain in situ ion fractions cannot be achieved in the corona even from a purely theoretical point of view without violating constraints on mass flux and in situ electron temperature (e.g. Esser et al. 2002).

We carried out more detailed studies to show that differential flow speeds between ions of the same element can not bridge the above gap between low coronal electron temperatures and high in situ ion fractions. (Chen, Esser and Hu 2002a; Chen Esser and Hu 2002b), neither can possible time variations of the coronal electron temperature (Esser et al. 2002). The only possibility is that the electrons have a non-Maxwellian distribution function (Esser and Edgar 2000).

1.2 Future Plans

We will use our theoretical solar wind codes to investigate in more details the physical properties of the electron temperature in the corona, and its effect on minor ion fractions and spectral line emission. The above studies were all carried out for the fast solar wind from polar coronal holes. In the next year we will also investigate the line ratio diagnostic in the slow solar wind.

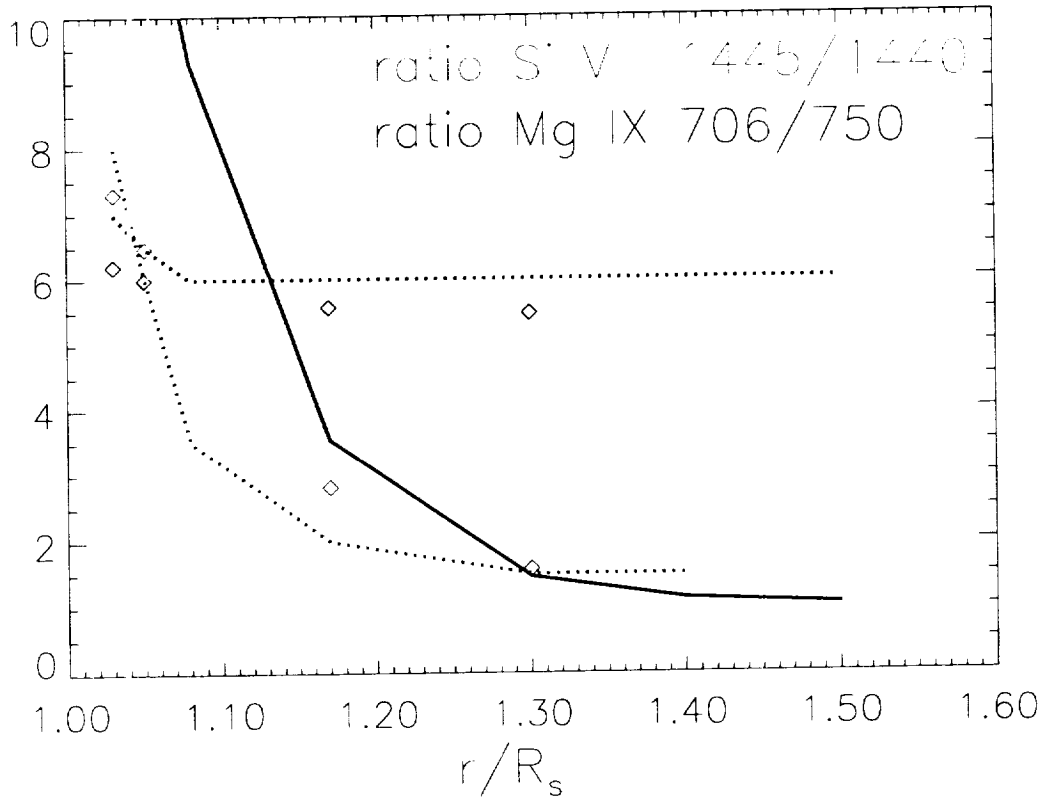

Fig. 1. Mg and Si line ratios from a typical electron temperature derived from in situ ion fractions (solid lines), line rations observed by SUMER (Wilhelm et al. 1998, dotted lines), and line ratios calculated from the temperatures and density derived from these SUMER observations, but using a different set of atomic data (CHIANTI) instead of the atomic data used in the Wilhelm et al. (1998) paper.

2. Publications and talks fully or partially funded by the grant

1. R. Esser and R. Edgar, Differential flow speeds of elements of the same ions: Effects on solar wind ion fractions, *Astrophys. J.*,**563**, 1055, 2002.

2. G. Poletto, S. T. Suess, D. A. Biesecker, R. Esser, G. Gloeckler, Y.-K. Ko and T. H. Zurbuchen, Low-latitude solar wind during the Fall 1998 SOHO-Ulysses quadrature, JGR, in press, 2002.

3. Y. Chen, R. Esser and Y.-Q. Hu, A theoretical model for O(+5) (O(+7)) ions in the fast solar wind, submitted to JGR.

4. R. Esser, O. Lie-Svendsen, Y. Chen and R. J. Edgar, Constraints on coronal heating derived from modeling solar wind ion compositions, Solar Wind 10 Conference, 2002.

5. R. Esser, Coronal Heating and the Acceleration of Solar and Solar-type Winds, Solar Wind 10 Conference, 2002.

6. Y. Chen, R. Esser and Y.-Q. Hu, 5-fluid models of C, O, Mg, Si and Fe in a 3-fluid solar wind background, to be submitted to ApJ, 2002.

In addition a number of seminar talks and invited talks on the above subjects were also given, e.g. at the University of Oslo, Norway, Plasmaphysics Conference, Tromsoe, Norway, IAGA meeting, Hanoi, Vietnam, University of Nagoya, Japan.